the paired frontal horns of Antelopes, Bovines, and Deer occupy very widely-separated positions in different genera. Dr. Ridewood has kindly prepared for me a diagram (text-fig. 36) showing these varied positions in a series of genera. The most remarkable position is that of the horn-cores of the Antelope *Cephalophus*, which is not fully exhibited in the diagram. The frontal in some species of this genus actually pushes out a process into the area of the parietal, upon which the horn-core rests. The horncores are seen (by reference to the diagram) to arise sometimes at the hinder margin of the frontal, sometimes on the orbital ring, sometimes in the anterior third of the frontal. The co-existence of two pairs in *Tetraceros* suggests a multiplicity of horns in ancestral forms.

The position of the horn-cores in the genus *Bos* is not marked in the diagram; it is identical with that of the posterior pair of *Tetraceros*.

 Parallel Hair-fringes and Colour-striping on the Face of Fœtal and Adult Giraffes. By E. RAY LANKESTER, M.A., D.Sc., LL.D., F.R.S., F.Z.S., Director of the British Museum (Natural History).

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(Plate V.* and Text-figures 37–48.)

When examining the feetal Giraffe which I received from the Society in the past summer, I observed a number of parallel bands or stripes of dark and light colour on the hairy coat of the



Left side of the head of the fœtal Giraffe described, showing colour-stripes on the snout and above and below the eye. The small arrows indicate the direction of slope of the hairs. About three-tenths of the natural size.

* For explanation of the Plate, see p. 125.

face—between the two lateral horn-sacs, also between the eyes and above the eyes, which are carefully represented in the coloured drawing (Plate V.) of the face of the fœtal Giraffe. I observed similar but more strongly marked and broader bands of alternating reddish-brown and paler colour between the nostrils (see Plate V. and also text-fig. 30, *supra*, p. 106) and at the side of the upper lip, on the front of the lower jaw and below the eye (text-fig. 37, p. 115).

The colour-bands between the horns and the eyes varied in intensity according to the angle of the incident light, and could be temporarily destroyed by pressing the skin and smoothing down the hair. After careful examination of the hairs, I came to the conclusion that there was no actual difference of colour in the hairs occupying the darker stripes and those placed on the lighter tracts, but that the phenomenon was due to the existence of parallel linear depressions or wrinkles the existence of which was made obvious by a transverse section of the integument (text-fig. 38). The hairs are crowded together in the trongh of the wrinkle, and further apart in the convex intermediate areas. That "wrinkling" could produce such an impression of dark and light banding was demonstrated by the casual folds and wrinkles of the integument on the legs, and by purposely producing such wrinkles by pressing or folding the hairy integument.

Text-fig. 38.



Section across three dark-coloured bands above the eye of the fœtal Giraffe, showing three longitudinal furrows or depressions in transverse section corresponding to the dark bands. Magnified.

Nevertheless I could not attribute the colour-banding to a mere accidental or casual formation of wrinkles. Their definite form and arrangement precludes such an explanation. They appeared to me to be the expression of a definite structural condition. Moreover, immediately over the eyes and on the snout the difference of colour of the alternating bands was very strong, the darkly-coloured stripes being of a strong reddishbrown tint and the intermediate bands quite pale; and in this case a pigment was present in the hairs of the darker stripes which was not so richly developed in those of the lighter neighbouring stripes. I found, on microscopic examination of the hairs, that they could be roughly divided into three sizes;

1907.] COLOUR-STRIPING ON THE FACE OF GIRAFFES.

the largest, few in number; medium-sized, more numerous; and a smallest size, the most abundant (text-fig. 39). The two larger sizes of hair were remarkable for appearing almost colourless in their lower (proximal) moiety and very dark in the upper (distal)

Text-fig. 39.

Section of the skin of the frontal region of the fœtal Giraffe, showing three sizes of hairs. Greatly magnified.

moiety. The smallest hairs were dark-coloured throughout. When a piece of the hairy colour-banded region was examined with a strong lens, the tips of the hairs were seen to converge from the two sides of the shallow furrows or wrinkles as shown in the text-figure 40. The superposition of the darker free ends of the hairs conceals their paler basal regions, and thus intensifies the difference between the apparent colouring of the troughs or wrinkles and the intermediate spaces where the hairs do not converge. An interesting experiment in regard to this matter was made by my assistant Dr. Ridewood. He took a piece of pale hat-maker's plush, and stained with dark pigment the free ends of its hairy surface. He found that on throwing this manufactured material into a series of wrinkles, very strong alternation



Surface-view of banded "pelage" of the frontal region of factal Giraffe, showing the convergence of the hairs at the three longitudinal bands of dark appearance. Magnified.

of dark and light colour-stripes could be produced. (This prepared material was shown to the Meeting and dark and light bands produced in it and removed at pleasure by alternately throwing it into wrinkles and stretching it so as to remove the wrinkles.)

Although these colour-stripes on the head of the foctal Giraffe thus appear not to be due to alternate tracts of hair of differing colour, it seems to me that they have a real existence as effective colour-marking, and that their structural cause is to be found in the differentiation of the attachment of the panniculus carnosus



An enlarged drawing of a single hair of average size from the frontal region of an adult Giraffe (*Giraffa camelopardalis wardi*), showing the dark pigmented free extremity and the opaque white lower portion.



Colour-striping on the face of an adult male Giraffe from Kordofan (G. c. antiquorum). Drawn from a specimen living in the Society's Gardens.



Colour-striping on the face of an adult female Giraffe from Kordofan (G. c. antiquorum). Drawn from a specimen living in the Society's Gardens.

1907.] COLOUR-STRIPING ON THE FACE OF GIRAFFES.

to the integument, and in the related direction and convergence of the hairs in definite bands or hair streams. An examination of the adult Giraffe establishes the truth of this view. I visited the Giraffe-house at the Society's Gardens in order to examine the father of the fætal specimen in which I had observed this colour-striping. The father is a Kordofan specimen, and there is also in the Giraffe-house a female Kordofan Giraffe. I was not a little surprised to find very strongly-marked colour-striping over the eyes of both these Giraffes, especially well-marked in the female. Portions of the muzzle are also banded, and between the eye and the angle of the mouth are developed from four to six



Colour-striping on the face of *Giraffa camelopardalis cottoni* from Mt. Elgon, Uganda. This specimen shows a horn-like exostosis over the right eye. Drawn from a specimen in the British Museum.

strongly-marked horizontal colour-bands which are not present in the factus (see text-figs. 42 & 43). I found that when the eye was shut and the skin above the eye stretched, the strongly-marked dark and light bands disappeared giving place to an irregularly blotched appearance *, which immediately resolved itself into alternate dark and light bands when the eye was opened and the

* It seemed to me that there were in this region definite tracts in which the pigmentation of the hair was pale, and others in which it was dark, but exact observation was, I found, impossible in the living animal.

superciliary region thrown into the normal condition assumed when the animal is alert. I also noticed that though the horizontal bands between eye and mouth never actually disappear, they are intensified by a muscular contraction resembling a sneer which sometimes is exhibited by the Giraffe. I found that the third Giraffe in the Gardens (a West African specimen) did not exhibit any colour-bands on the face.



Colour-striping of the face and muzzle of a Transvaal Giraffe (Giraffa camelopardalis wardi). Drawn from a specimen in the British Museum.

I next proceeded to examine from this point of view the fine series of Giraffe heads and necks exhibited in the public gallery of the British Museum, as well as several unmounted skins. I found that several of these specimens exhibit colourbanding over the eye and some of them below it, whilst these same specimens exhibit strong horizontal "fringes" or banding of the hair between the eye and muzzle, and some also show banding on the lower lip (see text-figs. 44–48). On the other hand, some of the specimens exhibit little or no trace of these bands. In none have I found any trace of the bands in the mediad position between the horns and between the eyes, shown by the fœtal specimen drawn in Plate V., which itself shows no trace of the pre-orbital horizontal stripes.

1907.] COLOUR-STRIPING OF THE FACE OF GIRAFFES.

The bands of alternate light and dark colour are as much larger and wider in the adult Giraffe as are all its dimensions larger than those of the fœtus. But a fact in regard to the banded appearance of the hairy coat of the face has come to light in the case of the adult skins which is indicated in the enlarged drawing of a piece of the fœtal pelage (text-fig. 40, p. 118). This is that the bands are essentially due (at any rate, those which are peculiar to the adult and most strongly-marked, viz., the horizontal pre-orbital group of bands) to a differentiation of the hair into parallel tracts of more densely placed hairs, the points of



The same specimen as that shown in text-fig. 45. In this drawing the colour-effect is ignored, and only the ridge-like arrangement of the hair on the face and muzzle in parallel fringes is shown.

which converge and stand up so as to form a well-marked raised stripe, "fringe" or "ridge"*, and intermediate tracts of smooth flat-lying hair. In some of the Museum specimens the more crowded upstanding hairs *appear* to be coloured more darkly than those of the intermediate tracts, but really the colour-effect is due to the pigment of the free ends of the hairs showing, whilst the thicker cortical substance of the bases of the hairs is white

* The *ridge* of upstanding hair corresponds, it must be noted, to what is a shallow wrinkle-like *groove* in the feetal skin.



Colour-striping (very slightly developed between eye and nostril) of the face of a Somali-land Giraffe (*Giraffa reticulatus*). Drawn from a specimen in the British Museum.



The same specimen as that shown in text-fig. 47, but with all colour omitted. The parallel bands between eye and nostril are not marked out in colour, but are merely elevated fringes or ridges of hair traversing a colourless region.

1907.] COLOUR-STRIPING OF THE FACE OF GIRAFFES.

(text-fig. 41, p. 119). In one Somali specimen (*G. reticulatus*) the hairs are entirely white over a large part of the region of the face where the horizontal bands are developed. Yet these horizontal bands show up very distinctly on account of the more erect setting of the hairs (see text-figs. 47 & 48). In some cases the hairs of these ridges seem to have yielded more readily to destructive processes connected with taxidermy than have the hairs of the neighbouring tracts, and consequently the bands are marked out by nearly bald furrows or pathways.

Another point of interest is that one of the horizontal preorbital hair-bands in the adult Giraffe directly leads up to the pre-orbital hair-whorl, and that the position of this hair-whorl appears to be farther in front of the eye in the Somali *G. reticulatus* than in other Giraffes, whilst undoubtedly the hair is more erect and strongly developed on those ridges and on the hairwhorl in that species than in the other Giraffes which I have been able to examine.

It would be interesting to ascertain how far the varying development of these colour-bands and parallel hair-ridges on the face of the Giraffe is constant in the different local varieties of Giraffe which have been distinguished. This is not a matter with which I am at present able to deal. The purpose of the present communication is to call the attention of zoologists to a banded structure of the integument of the face in Giraffes which results in the appearance of dark and light parallel bands of hair and in the formation of strongly-marked parallel fringes or ridges of erect hair separated by bands of recumbent hair. These structures are recorded in a feetal and in adult Giraffes, and appear to have hitherto escaped attention.

The production of optically effective colour-bands by the mere crowding and direction of hairs along certain lines, without actual difference in the pigmentation of the hairs of the lighter and darker stripes, has possibly some significance in regard to the origin and development of the more definite striping of the mammalian pelage so frequently shown, when dark and light stripes distinguished from one another are caused by the actual presence of pigment in the hair of the dark stripes, and its absence in the hair of the lighter or white stripes.

EXPLANATION OF PLATE V.

Coloured drawing of the head and face, seen from above, of the fœtus of a Giraffe removed from its mother which died in the Society's menagerie in April 1906.

The head of the foctus measured seven inches and one quarter from the anterior angle of the base of the outer ear to the extreme border of the upper lips.

The specimen had been preserved in alcohol for six months.

Details concerning the parentage &c. of this foctus are given by Mr. Beddard in Proc. Zool. Soc. 1906, p. 626.